Detection, prevention and direct post-operative intervention in orthopaedic implant infection

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SUMMARY

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In Chapter 1 a general introduction has been given to the problem of biomaterial-related infection in orthopaedic surgery. The aim of this thesis is formulated as to investigate the reasons for diagnostic problems of infection in total joint prostheses in a University hospital setting. Diagnostic problems are analyzed during the work up for revision surgery as well as during the peri-operative hospital stay after primary hip replacement. A possible method of preventing clinical signs of infection of a percutaneous orthopaedic implant, which is even more susceptible to infection than totally internal implants, is investigated in an animal model.

In Chapter 2 an overview has been given of biomaterial-related infections and why they need special attention. Special attention to minimize contamination risks has to be brought to the attention of non biomaterial-associated Operating Room (OR) personnel. The problem we encountered in this particular part was the difficulty to maintain this attention at a high level. The latter is especially a problem in our specific setting, a large academic hospital, in which there is a constant rotation of OR personnel in training. It turned out to be of the utmost importance that the constant factors, e.g. the dedicated orthopaedic scrub team together with our orthopaedic staff, worked together to keep OR personnel focused on the specific biomaterial–associated OR attitude.

The objective of the study in Chapter 3 was to detect possible bacterial contamination in total hip arthroplasty through instruments used at the direct site of implantation during the primary procedure. In this study samples of the broaches used for preparing the acetabulum and femur, as well as samples of the reamed acetabular and femoral bone, were collected during

67 consecutive primary total hip arthroplasties in 67 patients. Broach samples were taken at the start and end of every reaming procedure. The total number of samples taken amounted to 402, of which 26 were found to be positive for micro-organisms. In 20 patients, at least one of these positive samples had been in direct contact with the actual prosthesis site, indicating that at least 30% of the involved patients had a possible bacterial contamination when leaving the operating theater.

The objective of the study in Chapter 4 was to describe the extended culturing method that has been developed at the Department of BioMedical Engineering of our University. This method has been used for culturing tissue excised in revision surgery for septic as well as presumed aseptic loosing of joint prostheses. We have retrieved 33 prostheses or prosthetic components. In only one of the 33 cases micro-organisms were detected by routine culturing of tissue, while extensive culturing demonstrated infectious organisms in tissue samples in 14 cases. In addition, extensive culturing of the biomaterial scrapings identified 6 other cases of positive cultures, totalling the percentage of infected cases by extensive culturing to 60% (20 out of 33 patients). These results demonstrated that biomaterial-associated infections may well remain undetected by standard clinical and microbiological hospital procedures

The objective of the study in Chapter 5 was to evaluate the feasibility of 2-[^{18}F]fluoro-2-deoxy-D-glucose-Positron emission tomography (FDG-PET) for the differentiation between septic and aseptic loosening of joint prostheses. Seven patients with a painful joint prosthesis had a revision procedure of this prosthesis within 6 weeks after PET scanning. Four patients had an intense FDG uptake. At revision, 3 patients were diagnosed as septically loosened, and one had an infectious-like mass around the stem. The other three had mild activity and were

diagnosed as aseptically loosened. Five control patients with 7 asymptomatic joint prostheses went through a PET scan for an oncological problem. The PET activity varied between no (N=1), mild (N=5) and intense (N=1). We concluded that the introduction of a joint prosthesis apparently causes a mild increased FDG uptake, suggesting the evocation of a chronic inflammation. An intense uptake of FDG could be suggestive of a summation of activity from a possible infectious origin.

The objective of the study in Chapter 6 was to investigate whether a 100 μA electric current can prevent signs of clinical infection around percutaneous pins, implanted in the tibia of goats. Three pins were inserted into the lateral right tibia of nine goats, of which one served for additional frame support. Two pins were infected with a *Staphylococcus epidermidis* strain of which one pin was subjected to electric current, while the other pin was used as control. Pin sites were examined daily. The wound electrical resistance decreased with worsening of the infection from a dry condition to a purulent stage. After 21 days, animals were sacrificed and the pins taken out. Infection developed in 89% of the control pin sites, whereas only 11% the pin sites in the current group showed infection. These results show that infection of percutaneous pin sites of external fixators in reconstructive bone surgery can be prevented by the application of a small DC electric current.

The objective of the study in Chapter 7 was to evaluate the results of an ad hoc versus a protocolled approach, with regard to the recording of persisting wound drainage after placement of a primary joint prosthesis and the salvage of prostheses in patients with persisting wound drainage. In this study, 247 patients with 250 prostheses formed group I (ad hoc approach) and were observed and treated by an orthopaedic surgeon in the absence of a protocol. In group II (protocolled group), 304

patients with 308 prostheses were observed and treated according to the proposed protocol.
The percentage of patients with a registered persisting drainage of the operative wound in group II was almost twofold the percentage of group I (21% and 11%, respectively). Yet, the number of open debridements carried out in group II (17%) was lower than in group I (30%). The salvage rate of prostheses with persisting drainage in group II (94%) was higher than in group I (85%). However, the main advantage was seen in the percentage of salvaged prostheses which were not debrided and amounted 98% in group II versus 90% in group I.
Besides better registration, a protocolled approach enables more successful election of patients in which open debridement is not necessary.

The general discussion in Chapter 8 illustrates that the so-called "Hawthorne-effect", can be an effective means in optimizing behaviour of personnel involved in the chain of care for patients with an orthopaedic implant. This optimized behaviour is realized by creating a greater awareness and stimulating changes in a broader community. This community is expanded beyond those solely involved with research. This kind of research is considered to be equally important on a local level than world-wide dissemination of knowledge.